PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 7/36	A1	(11) International Publication Number: WO 97/32440 (43) International Publication Date: 4 September 1997 (04.09.97)

(21) International Application Number: PCT/SE97/00306

(22) International Filing Date: 24 February 1997 (24.02.97)

(30) Priority Data:
08/607,808 27 February 1996 (27.02.96) US

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventors: DULONG, Daniel; 48 Racine, Pincourt, Quebec J7V 8E9 (CA). BRUNNER, Richard; 5103 Jeanne d'Arc, Montreal, Quebec H2X 2E6 (CA). NGUYEN, Chong; Apartment E, 4661 Hope Valley Road, Durham, NC 27707 (US).

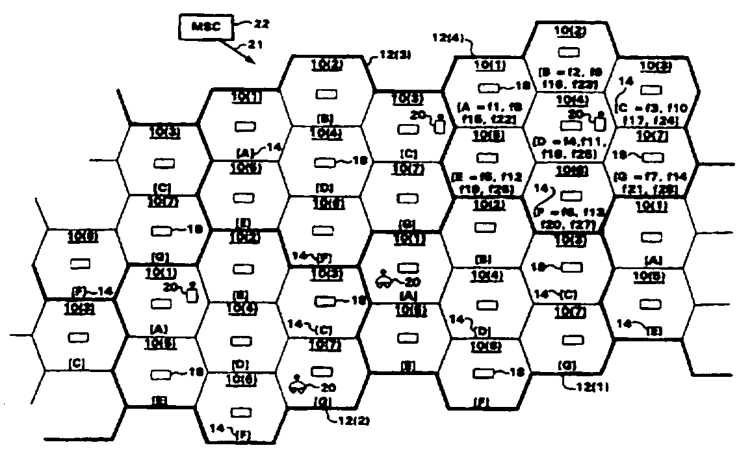
(74) Agents: BANDELIN, Hans et al.; Telefonaktiebolaget LM Ericsson, Patent and Trademark Dept., S-126 25 Stockholm (SE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: VOICE CHANNEL SELECTION FOR REDUCED INTERFERENCE IN A FREQUENCY REUSE CELLULAR SYSTEM



(57) Abstract

The cellular frequency band supporting a plurality of voice channels is divided into a plurality of frequency groups ([A] - [G]) each assigned to (i.e., reused in) multiple cells in a cellular telephone system. The voice channel allocated to a mobile station (20) comprises that channel selected from the frequency group for the cell (10) where the mobile station is currently located which has not concurrently been allocated (116) to another mobile station in a proximately located cell also assigned that same frequency group. The frequency groups may further be partitioned into a plurality of sub-sets (24) each being individually prioritized on a per cell basis such that proximate cells reusing the same frequency group have differing sub-set prioritizations. At channel allocation, a preference is given to those channels for the cell where the mobile station is currently located that have a higher sub-set prioritization. Such concurrent use and prioritization analyses serve to efficiently spread communications load across the cellular frequency band, and minimize the risk of co-channel interference.

VOICE CHANNEL SELECTION FOR REDUCED INTERFERENCE IN A FREQUENCY REUSE CELLULAR SYSTEM

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to cellular telephone systems and, in particular, to a method and apparatus for effectuating efficient voice channel selection with reduced interference.

Description of Related Art

Cellular telephone systems divide a large service area into a number of smaller discrete geographical areas called "cells" each typically ranging in size from about one-half to about twenty kilometers in diameter. Each cell is contiguous with multiple adjacent cells to provide continuous coverage throughout the service area. A base station including a plurality of transceivers capable of operating independently on different radio frequencies is provided for each of the cells. Via the transceivers, the base stations engage in simultaneous communications with plural mobile stations operating within the area of the associated cell. The base stations further communicate via data links (and voice trunks) with a central control station, commonly referred to as a mobile switching center, which functions to selectively connect telephone calls to the mobile stations through the base stations and, in general, control operation of the system.

Each cell is assigned use of a predetermined set of frequencies from the cellular frequency band for use in providing its analog and/or digital voice channels. The

availability of multiple voice channels per cell permits base stations to simultaneously handle many telephone conversations with many mobile stations. The frequencies used for the voice channels assigned to a given cell are preferably spaced apart from each other across the frequency spectrum of the cellular frequency band. This serves to minimize the instances and adverse affects of adjacent channel interference.

Because only a limited number of frequencies are available in the cellular frequency band, the same frequencies that are assigned to one cell are also assigned to (i.e., reused by) other cells in distant parts of the service area. Typically, adjacent cells are not assigned to use the same frequency. Furthermore, the power levels of the signal transmissions on any given frequency are limited in strength so as to limit propagation beyond the cell area. The foregoing precautions serve to reduce instances of co-channel interference caused by reuse of that same frequency in a distant cell.

In spite of the precautions taken by service providers in assigning the frequencies in frequency reuse cellular systems and regulating system operation, it is known that instances of co-channel interference do occur. This interference often adversely affects system operation by, for example, degrading voice quality on the voice channels or interfering with the transmission and reception of control signals on the control channels.

The mobile switching center functions to dynamically allocate the voice channels (comprising the assigned voice frequencies in analog systems or time slots therein for

digital systems) available in any one cell among the plurality of mobile stations located within the cell area that desire communications. Commands that allocate for mobile station use a certain voice channel assigned to a given cell are transmitted from the mobile switching center to the base station for that cell. The commands are then relayed by the base station to the certain mobile station over one of the assigned frequencies to direct mobile station access to the allocated voice channel for handling the call.

Allocation by the mobile switching center of a particular voice channel in a cell to a particular mobile station for a call primarily occurs in two instances. The first instance is at call set-up when the subscriber activates the mobile station to initiate (i.e., originate or terminate) a call and the system selects the voice channel to carry that call. The second instance is at call hand-off when the subscriber, while engaged in a call, moves from one cell in the service area to another cell, and the system allocates a voice channel in the new cell to handle the on-going call.

The portion of the frequency spectrum comprising the cellular frequency band provided for use in an analog cellular telephone system, such as the advanced mobile phone system (AMPS), or digital cellular telephone system, such as the D-AMPS or Global System for Mobile (GSM) Communications, includes a group of frequencies in a normal frequency band and a group of frequencies in an extended frequency band. Typically, there are more frequencies (and hence voice channels) in the normal band than there are in the extended band. Most mobile stations

(in fact, it is estimated that as many as eighty percent of the mobile station population) are capable of operation in both the normal band and the extended band. Unfortunately, these mobile stations have a preference (accommodated by the conventional channel allocation process implemented by the mobile switching center) for operation in the extended band. The preferred allocation of voice channels in the extended frequency band accordingly inefficiently utilizes the available communications resources of the cellular telephone system, resulting in crowding, increased competition, and a greater likelihood of experiencing instances of co-channel interference.

There is therefore a need for a method and apparatus for use in cellular telephone systems that facilitates a more efficient use of the cellular frequency band while minimizing instances of co-channel interference.

SUMMARY OF THE INVENTION

In a frequency reuse-type cellular telephone system, the cellular frequency band is divided into a plurality of groups of frequencies, with each group assigned to multiple cells. For one embodiment of the present invention, the groups of frequencies are then partitioned into a plurality of sub-sets of frequencies, with the sub-sets within each frequency group individually prioritized on a cell-by-cell basis such that proximately located cells reusing the same frequency group have differing frequency sub-set prioritizations. In allocating analog or digital voice channels within those frequencies to mobile stations for use in carrying cellular

communications, the system gives preference within each cell to those voice channels associated with frequencies assigned to that cell having a higher sub-set prioritization. By allocating voice channels in this fashion, communications load is spread efficiently across the cellular frequency band, and the risk of instances of co-channel interference is minimized.

In accordance with another embodiment of the present invention, the cellular frequency band is again divided into a plurality of groups of frequencies, with each group assigned to multiple cells. In allocating analog or digital voice channels within those frequencies to mobile stations for use in carrying cellular communications, the system determines whether a chosen one of the voice channels is concurrently being used in a proximately located cell that reuses the same frequency group. When concurrent use is detected, an alternate voice channel is chosen and subjected to the concurrent use analysis. Allocation of a voice channel is not made until the system finds that the chosen voice channel is not concurrently being used in any of the proximately located cells reusing the same frequency group. By allocating voice channels in this fashion, communications load is spread efficiently across the cellular frequency band, and the risk of instances of co-channel interference is minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be obtained by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 is an exemplary cell diagram schematically illustrating the frequency assignment architecture of a frequency reuse cellular telephone system;

FIGURE 2 illustrates the division of the cellular frequency band into groups of frequencies, with the frequency groups being distributed amongst the cells in one given cluster;

FIGURE 3 illustrates the division of a group of frequencies into sub-sets of frequencies, as well as the differing prioritization of the sub-sets across a plurality of cells that are assigned use of the same frequency group;

FIGURE 4 is a flow diagram for the allocation of voice channels in accordance with the sub-set prioritization illustrated in FIGURE 3; and

FIGURE 5 is a flow diagram for the allocation of voice channels depending on detection of concurrent use in a proximate cell assigned use of the same frequency group.

DETAILED DESCRIPTION OF THE DRAWINGS

There are a plurality of radio frequencies in the cellular frequency band available to cellular telephone system providers for use in communicating with mobile stations. A majority of the available radio frequencies are reserved for the voice channels used in carrying telephone calls. In an analog cellular telephone system, like the known advanced mobile phone system (AMPS), there is one frequency division multiple access (FDMA) analog voice channel per frequency. In a digital cellular telephone system, like the known D-AMPS or Global System

for Mobile (GSM) Communications, there are a plurality of time division multiple access (TDMA digital voice channels (time slots) per frequency. The remaining radio frequencies in the cellular frequency band are reserved as control channels for carrying the control signals (commands) used to direct operation of the system. Alternatively, the control channel comprises one time slot on a frequency shared with plural voice channels. The control signals transmitted over the control channel comprise call originations, page signals, page response signals, location registration signals, voice channel assignments, maintenance instructions, and cell selection or reselection instructions.

A common cellular system frequency assignment architecture provides for a normal frequency band plus an extended frequency band within the overall cellular frequency band. In one example, a first plurality of the radio frequencies in the normal band portion of the cellular frequency band are reserved for the control channels utilized by the system on an at least one control channel per cell basis to carry cellular system operation control signals and messages between mobile stations and base stations. A second plurality of the frequencies from both the normal and extended bands are reserved for the voice channels, and are typically divided more or less equally amongst the cells and allocated on as needed basis by the system to subscribers for carrying cellular voice communications between mobile stations and base stations.

A cellular service area can cover a large geographic region, and in many instances there will be a need for a large number of cells. Often times, the number of cells

needed exceeds in number the number of cells provided by dividing the available frequencies amongst the cells in such a manner as to handle expected subscriber usage per cell. In such a case there are simply not enough frequencies in the cellular frequency band for unique assignment to the included cells. Accordingly, in order to provide sufficient call handling capacity throughout the service area, the cells are grouped into clusters of cells and the frequencies in the cellular frequency band are divided amongst and reused in each of the clusters.

Reference is now made to FIGURE 1 wherein there is illustrated a known cell structure and frequency assignment architecture for use in a radio frequency reuse cellular telephone system. An arbitrary geographic region (hereinafter "the service area") is divided into a plurality of contiguous cells 10 schematically represented by hexagons. The cells are then grouped into clusters 12 (outlined in bold to ease recognition). For example, in the cell structure of FIGURE 1, each cluster 12 includes seven cells 10(1)-10(7). It will, of course, be understood that each cluster 12 may have more or less cells 10 as needed.

The available frequencies in the cellular frequency band (including those in the normal and extended bands) are divided in accordance with the frequency assignment architecture into groups of frequencies 14, with the frequency groups distributed amongst the cells 10 of each cluster 12 such that the radio frequencies of the cellular band are reused in each cluster. For example, in a cell structure having seven cells 10 per cluster 12 like that shown in FIGURE 1, there are seven frequency groups 14

identified and differentiated from each other by the alphabetic labels "A" through "G" corresponding to the cells 10(1)-10(7), respectively. Thus, each cell 10(1) in the service area is assigned use of radio frequencies in frequency group A, each cell 10(2) is assigned use of radio frequencies in frequency group B, and so on up to each cell 10(7) being assigned use of radio frequencies in frequency group G.

The reuse of the frequencies may be better understood through the use of a particular analog cellular telephone system example, wherein it is assumed that a total of twenty-eight radio frequencies fn (n=1 to 28) are available in the cellular frequency band. It will, of course, be understood that the cellular frequency band includes hundreds of frequencies. In this example, the first seven of the frequencies f1-f7 are reserved as analog control channels, assigned one each to the groups of frequencies 14 A through G, respectively, and distributed one control channel per cell to cells 10(1)-10(7). Thus, the first control channel radio frequency f1 in frequency group 14 A is assigned to each cell 10(1), control channel frequency f2 in frequency group B is assigned to cell 10(2), and so on up to control channel frequency f7 in frequency group G being assigned to cell 10(7). The remaining radio frequencies f8-f28 are reserved as analog voice channels, and are divided equally into the frequency groups 14 A through G, and distributed amongst the cells 10(1)-10(7) to provide three voice channels per cell. Thus, each of the cells 10(1) across the service area is assigned frequency group 14 A including control channel radio frequency f1, and voice

channel frequencies f8, f15 and f22. Similar assignments of the frequency groups 14 B through G are made for each of the remaining cells 10(2)-10(7), respectively, with the frequency groups also being reused across each of the included clusters 12. The complete assignment of the radio frequencies f1-f28 for the frequency groups 14 A through G to the cells 10(1)-10(7) in each cluster 12 in accordance with this example of cellular frequency reuse is illustrated in detail in FIGURE 1 with respect to cluster 12(4).

It will be noted that in the frequency reuse architecture adjacent cells are typically not assigned use of the same radio frequency. Reuse of an identical radio frequency in the service area is preferably made with a separation of at least one cell 10 along with a regulation of broadcast power from each cell to constrain radio propagation substantially within the cell area. Furthermore, it will be noted that typically no one cell 10 utilizes adjacent radio frequencies in the cellular band. Adjacent radio frequencies are preferably assigned no closer than one cell 10 away each other. By arranging the cells 10 in clusters 12 as shown in FIGURE 1, regulating broadcast power of communications within the cell as mentioned above, and further by assigning frequencies in the fashion described above and shown in FIGURE 1, the likelihood of interference is reduced while simultaneously providing effective cellular communications services across a very large service area.

In spite of the precautions taken to avoid interference, it is known that interference does occur in cellular systems like that previously described. One

aspect of this interference originates from same analog or digital channel communications occurring simultaneously in the cells 10 of other clusters 12 (i.e., co-channel interference). To understand this phenomena, assume with reference to FIGURE 1 the existence of concurrent voice communications in frequency group C on an analog voice channel or digital voice channel associated with frequency f10 in any one or more of the cells 10(3) in the clusters 12(2), 12(3) and/or 12(4) of the service area. In spite of any imposed broadcast power limitations, a certain amount of the radio frequency energy of those voice communications propagates beyond the respective cell boundaries and is injected as interference into the voice channel(s) for frequency f10 of frequency group C in other cells 10(3), for example, in cell 10(3) of cluster 12(1).

Each of the cells 10 in a cellular system such as that illustrated in FIGURE 1 includes at least one base station (BS) 18 configured to facilitate radio frequency communications with mobile stations 20 moving throughout the service area. The base stations 18 are illustrated as being positionally located at or near the center of each of the cells 10. However, depending on geography and other known factors, the base stations 18 may instead be located at or near the periphery of, or otherwise away from the centers of, each of the cells 10. In such instances, the base stations 18 may broadcast and communicate with mobile stations 20 located within the cells 10 using directional rather than omni-directional antennas. The base stations 18 are connected by communications links (generally shown by arrow 21) to at least one mobile switching center (MSC) 22 operating to

control the operation of the system for providing cellular communications with the mobile stations 20.

Reference is now made to FIGURE 2, wherein there is shown a schematic illustration of the distribution of the groups of frequencies 14 (A through G) amongst the cells 10(1)-10(7) in one given cluster 12. It is well known that the cellular frequency band includes frequencies in both a normal frequency band and frequencies in an extended frequency band. In dividing the frequencies of the cellular frequency band into the frequency groups 14, each frequency group acquires both normal band (nb) frequencies 16 and extended band (eb) frequencies 17.

The mobile stations 20 operable in the system of FIGURE 1 may comprise mobile stations configured for voice channel operation only on those frequencies of the normal frequency band (nb) 16, or alternatively comprise mobile stations capable of voice channel operation over frequencies in both the normal frequency band and the extended frequency band (eb) 17. In the case of mobile stations 20 operable over both bands, preference for operation is typically made in the system for use of the extended frequency band 17. Unfortunately, there are typically fewer voice channels assigned to the extended frequency band 17 than to the normal frequency band 16 (as is generally shown in FIGURE 2), and because perhaps as many as eighty percent of the mobile stations 20 do operate in both bands and prefer use of voice channels in the relatively smaller extended frequency band, inefficient use is made of the remaining available communications resources of the cellular telephone system (i.e., the normal frequency band). This results in

crowding, increased competition, and a greater likelihood of experiencing instances of co-channel interference on the voice channels of the extended frequency band 17.

To address the foregoing problems experienced with co-channel interference caused by inefficient use of the available cellular frequency band, the cellular frequency assignment architecture of the present invention partitions each of the frequency groups 14 into a plurality of sub-sets of frequencies with the frequency sub-sets being individually (i.e., differently) prioritized at least with respect to proximately located cells 10. These frequency sub-sets may comprise as many different frequencies as desired, including as few as one frequency per sub-set. In accordance with the frequency sub-set prioritization provided by the cellular frequency assignment architecture, proximately located cells 10 that are assigned reuse of the same frequency group 14 emphasize allocation of different frequencies in the cellular frequency band to the mobile stations 20 for use as their analog or digital voice channels.

The partitioning of the frequency groups 14 and prioritization of the frequency sub-sets in accordance with the cellular frequency assignment architecture of the present invention may be better understood by referring to FIGURE 3 in connection with the specific cellular frequency architecture example previously described and shown in FIGURE 1. The frequency groups 14 (A through G) are partitioned into n frequency sub-sets 24 (A(1)-A(n) through G(1)-G(n)) each. It will, of course, be understood that the number (n) of sub-sets 24 may be different for each frequency group 14 if necessary.

FIGURE 3 illustrates the partitioning of one frequency group 14 A with respect to the cells 10(1) of clusters 12(1)-12(4) for the system of FIGURE 1 into n frequency sub-sets 24 (A(1)-A(n)). Similar partitions (not shown) are made with respect to the remaining frequency groups 14 for the cells 10(2)-10(7) in the cluster 12. The prioritization of the frequency sub-sets 24 preferably differs across the plurality of cells 10 assigned the same frequency group, and at a minimum differs with respect to proximately located cells. For the cells 10(1) illustrated in FIGURE 3 and assigned frequency group 14 A, for example, cell 10(1) of cluster 12(1) gives priority for mobile station allocation to the frequencies in sub-set 24 A(1), while proximately located cell 10(1) of cluster 12(2) gives priority for mobile station allocation to the frequencies in sub-set 24 A(2), and so on. Similar prioritizations (not shown) are made with respect to the frequency sub-sets 24 within the frequency groups 14 assigned to cells 10(2)-10(7).

In allocating individual analog or digital voice channels to mobile stations 20 for use in carrying cellular communications, the system gives preference within each cell 10 to the channels associated with those frequencies assigned to that cell having a higher frequency sub-set 24 prioritization. Thus, continuing with the foregoing example concerning the cells 10(1) present in the service area, a preference is given to allocating voice channels to a mobile station 20 in cell 10(1) of cluster 12(1) in those frequencies that are within sub-set 24 A(1) than in any other frequencies within the assigned frequency group 14 A because such

frequencies have a higher sub-set priority. Similarly, in accordance with the prioritization, a mobile station in cell 10(1) of cluster 12(4) is more likely to be allocated a voice channel associated with a frequency within sub-set 24 A(4) than in any other frequencies due to the provided sub-set prioritization. Of course, if all of the voice channels associated with frequencies in one sub-set 24 are unavailable, a preference is then given to allocating voice channels associated with frequencies in the next highest priority sub-set 24. By allocating voice channels in this fashion, communications load is spread efficiently across the cellular frequency band (fully utilizing both the normal and extended bands), and the risk of instances of co-channel interference is minimized.

FIGURE 4 is a flow diagram for cellular system operation in controlling the allocation of voice channels in accordance with the cellular frequency assignment architecture of FIGURE 1 and the sub-set prioritization illustrated in FIGURE 3. In allocating a voice channel to a mobile station in connection with either a hand-off or a call set up, the system (preferably operating by and through one of its mobile switching centers 22) first selects in step 100 in the highest priority sub-set of frequencies for the frequency group assigned to the cell which is serving the mobile station. An available voice channel associated with the selected sub-set of frequencies is then chosen in step 102 as the voice channel for the mobile station communication. If this operation is successful (as determined in decision step 104), the allocation process ends in step 106 with the chosen voice channel being allocated to the mobile

station. If, on the other hand, the operation of step 102 is unsuccessful (again determined by step 104), perhaps because all of the voice channels in the selected sub-set of frequencies are currently in use by other mobile stations, the system selects in step 108 a next highest priority sub-set of frequencies from the frequency group assigned to the cell which is serving the mobile station. The allocation process then returns to step 102 to choose an available voice channel in the selected sub-set of frequencies, and the process repeats itself, as often as necessary, until an available voice channel is found. When the operation of step 102 is unsuccessful and there are no more sub-sets of frequencies to select from (branch 110), the system has then failed to find an available voice channel in the cellular frequency band to be allocated and the hand-off or call set up channel allocation fails in step 112.

The operation of the system in allocating a voice channel in accordance with the process of FIGURE 4 may be better understood with reference to the prioritization of FIGURE 3 and a specific example wherein a mobile station is located in cell 10(1) of cluster 12(2) and desires to originate a cellular call. At call set-up, the system (preferably operating through one of its mobile switching centers 22) first selects (step 100) frequency sub-set 24 A(2) because it is of the highest priority for cell 10(1) of cluster 12(2). An available voice channel in frequency sub-set 24 A(2) is then chosen (step 102) to be allocated for handling the mobile station call (step 106). If there are no available voice channels in sub-set 24 A(2) as determined in step 104, the system selects (step 108)

frequency sub-set 24 A(3) because it has the next highest priority for cell 10(1) of cluster 12(2). The voice channel availability determination is then made again (step 102), with the process repeating itself and considering frequency sub-sets 24 with lower and lower priority until an available voice channel is found (step 106), or the assigned frequency sub-sets 24 available for consideration are exhausted (branch 110).

Reference is now made to FIGURE 5 wherein there is shown a flow diagram of the process used by the system in step 102 of FIGURE 4 in choosing a voice channel. In step 114, one of the available voice channels within the selected frequency sub-set is chosen. By "available" it is meant that the chosen voice channel is not currently being used by any other mobile stations in that particular cell. A determination is then made in decision step 116 as to whether the chosen voice channel is concurrently being used by another mobile station in a proximately located cell that has been assigned to the same frequency group. If the answer is yes (branch 118), then the process returns to step 114 to choose a different voice channel within the selected frequency sub-set. If the answer to decision step 116 is instead no (branch 120), then the chosen voice channel is allocated in step 122 to the base station for carrying a cellular communication. Steps 114 and 116 are repeated until an available voice channel (i.e., not currently in use in that cell or in a proximately located cell) is found and allocated to the mobile station. By allocating voice channels in this fashion, communications load is spread efficiently across

the cellular frequency band, and the risk of instances of co-channel interference is minimized.

Although the process of FIGURE 5 is disclosed as being a part of the sub-set analysis and voice channel allocation process of FIGURE 4, it will be understood that the process of FIGURE 5 may be implemented by the system (e.g., mobile switching center 22) independently of the allocation process of FIGURE 4. In such a case, the voice channel chosen in step 112 is instead chosen from the entire frequency group assigned to the cell rather than from only one selected sub-set of frequencies as has previously been described. In either case, the method is effective in providing for the selection of a voice channel with reduced interference.

The operation of the system in allocating a voice channel in accordance with the process of FIGURE 5 (within or independent of the process of FIGURE 4) may be better understood with reference to a specific example wherein a mobile station is located in cell 10(1) of cluster 12(2) and desires to originate a cellular call. At call set-up, the system chooses (step 114) a voice channel not currently in use within the cell 10(1) of cluster 12(2) which is then serving the mobile station 20. The determination of step 116 involves evaluating concurrent use of the chosen voice channel in the proximately located (i.e., neighboring) cells 10(1) of clusters 12(1), 12(3) and 12(4). Assume now that the chosen voice channel is in fact being used in cell 10(1) of cluster 12(3). The determination step 116 thus finds concurrent use and the system returns (via branch 118) to choose another voice channel in step 114. If instead no other mobile station

was using the voice channel in a neighboring cell, the determination step 116 fails to find concurrent use, and the voice channel is allocated (Step 122) to the mobile station.

Although the method and apparatus of the present invention has been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiment(s) disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims. In particular, it will be understood that the present invention may be effectively utilized in connection with the allocation of either an analog or digital voice channel.

WHAT IS CLAIMED IS:

1. A radio frequency assignment architecture for a cellular telephone system, comprising:

a plurality of frequency groups within a cellular frequency band wherein each frequency group is assigned to and is reused in a plurality of cells within the cellular telephone system; and

a plurality of frequency sub-sets within each of the frequency groups wherein the frequency sub-sets are prioritized on a cell-by-cell basis such that proximately located cells within the cellular telephone system assigned the same frequency group have differing frequency sub-set prioritizations.

2. The radio frequency assignment architecture as in claim 1 wherein each frequency sub-set includes a plurality of individual radio frequencies within the cellular frequency band.

3. The radio frequency assignment architecture as in claim 1 wherein each frequency sub-set includes a single individual radio frequency within the cellular frequency band.

4. The radio frequency assignment architecture as in claim 1 wherein each radio frequency is associated with an analog communications channel.

5. The radio frequency assignment architecture as in claim 1 wherein each radio frequency is associated with a plurality of digital communications channels.

6. A cellular telephone system operating on radio frequencies within a cellular frequency band, comprising a plurality of cells, with each cell assigned one of a plurality of groups of radio frequencies within the cellular frequency band for voice channel use, each of the groups of frequencies being reused in the cellular telephone systems by plural ones of the cells, and wherein each of the groups of frequencies comprises a plurality of sub-sets of frequencies prioritized on a cell-by-cell basis such that proximately located cells assigned the same group of frequencies have differing prioritizations for their respective sub-sets of frequencies.

7. The cellular telephone system as in claim 6 wherein each sub-set of frequencies includes a plurality of the radio frequencies within the cellular frequency band.

8. The cellular telephone system as in claim 6 wherein each sub-set of frequencies includes a single radio frequency within the cellular frequency band.

9. The cellular telephone system as in claim 6 wherein the voice channels comprise analog voice channels.

10. The cellular telephone system as in claim 6 wherein the voice channels comprise digital voice channels.

11. In a frequency reuse cellular telephone system wherein a cellular radio frequency band supporting a

plurality of voice channels is divided into a plurality of frequency groups with each frequency group being assigned to plural cells within the cellular telephone system, a method for allocating voice channels to mobile stations operating within the cellular telephone system comprising the steps of:

choosing an available voice channel from a frequency group assigned to a given cell serving a mobile station; and

allocating the chosen voice channel to the mobile station provided that the chosen voice channels has not been concurrently allocated to another mobile station being served by a proximately located cell assigned to the same frequency group as the given cell.

12. The method of claim 11 wherein the step of allocating comprises the steps of:

determining whether the chosen voice channel has concurrently been allocated to another mobile station being served by a proximately located cell assigned the same frequency group as the given cell;

responsive to a determination of no concurrent allocation, allocating the chosen voice channel to the mobile station; and

responsive to a determination of concurrent allocation, choosing another available voice channel for allocation from the frequency group assigned to the given cell.

13. The method as in claim 11 wherein the voice channel comprises an analog voice channel.

14. The method as in claim 11 wherein the voice channel comprises a digital voice channel.

15. A cellular telephone system operating within a cellular frequency band divided to include a plurality of frequency groups, comprising:

a plurality of cells wherein multiple ones of the cells within the system are assigned use of the same frequency group;

a base station for each of the cells, the base station communicating with mobile stations over allocated channels within the frequency group assigned to that cell; and

a control unit connected to control base station allocation of channels within the cellular frequency band to mobile stations such that a channel chosen for allocation from the frequency group assigned to a given cell is allocated for mobile station use provided that the chosen channel has not been concurrently allocated to another mobile station being served by a proximately located cell assigned use of the same frequency group as the given cell.

16. The cellular telephone system as in claim 15 wherein the channel comprises an analog communications channel.

17. The cellular telephone system as in claim 15 wherein the channel comprises a digital communications channel.

18. In a frequency reuse cellular telephone system wherein a cellular radio frequency band supporting a plurality of voice channels is divided into a plurality of frequency groups with each frequency group being assigned to plural cells within the cellular telephone system, and each frequency group is partitioned into a plurality of frequency sub-sets prioritized on a cell-by-cell basis such that proximately located cells have differing frequency sub-set prioritizations, a method for allocating voice channels to mobile stations operating within the cellular telephone system comprising the steps of:

choosing a voice channel from a highest priority sub-set having an available voice channel within the frequency group assigned to a given cell serving a mobile station; and

allocating the chosen voice channel to the mobile station.

19. The method as in claim 18 wherein the step of allocating comprises the step of allocating the chosen voice channel provided that the chosen voice channel has not been concurrently allocated to another mobile station being served by a proximately located cell assigned to the same frequency group as the given cell.

20. The method of claim 19 wherein the step of allocating comprises the steps of:

determining whether the chosen voice channel has concurrently been allocated to another mobile station

being served by a proximately located cell assigned the same frequency group as the given cell;

responsive to a determination of no concurrent allocation, allocating the chosen voice channel to the mobile station; and

responsive to a determination of concurrent allocation, choosing another available voice channel for allocation from the frequency group assigned to the given cell.

21. The method of claim 18 further including the step of responsive to a failure to choose an available voice channel in a highest priority sub-set, choosing a voice channel in a next highest priority sub-set having an available voice channel within the frequency group assigned to a given cell serving a mobile station.

22. The method of claim 18 wherein the voice channel comprises an analog voice channel.

23. The method of claim 18 wherein the voice channel comprises a digital voice channel.

24. A cellular telephone system operating within a cellular frequency band divided to include a plurality of frequency groups, each frequency group being partitioned into a plurality of frequency sub-sets, comprising:

a plurality of cells wherein multiple ones of the cells within the system are assigned use of the same frequency group, the frequency sub-sets being prioritized

on a cell-by-cell basis such that proximately located cells have differing frequency sub-set prioritizations;

a base station for each of the cells, the base station communicating with mobile stations over allocated voice channels within the frequency group assigned to that cell; and

a control unit connected to control base station allocation of voice channels within the cellular frequency band to mobile stations such that a voice channel from the frequency group assigned to a given cell is chosen for allocation to the mobile station from a highest priority one of the frequency sub-sets having an available voice channel for allocation.

25. The cellular telephone system as in claim 24 wherein the control unit further allocates the chosen voice channel for mobile station use provided that the chosen voice channel has not been concurrently allocated to another mobile station being served by a proximately located cell assigned use of the same frequency group as the given cell.

26. The cellular telephone system as in claim 24 wherein the voice channel comprises an analog voice channel.

27. The cellular telephone system as in claim 24 wherein the voice channel comprises a digital voice channel.

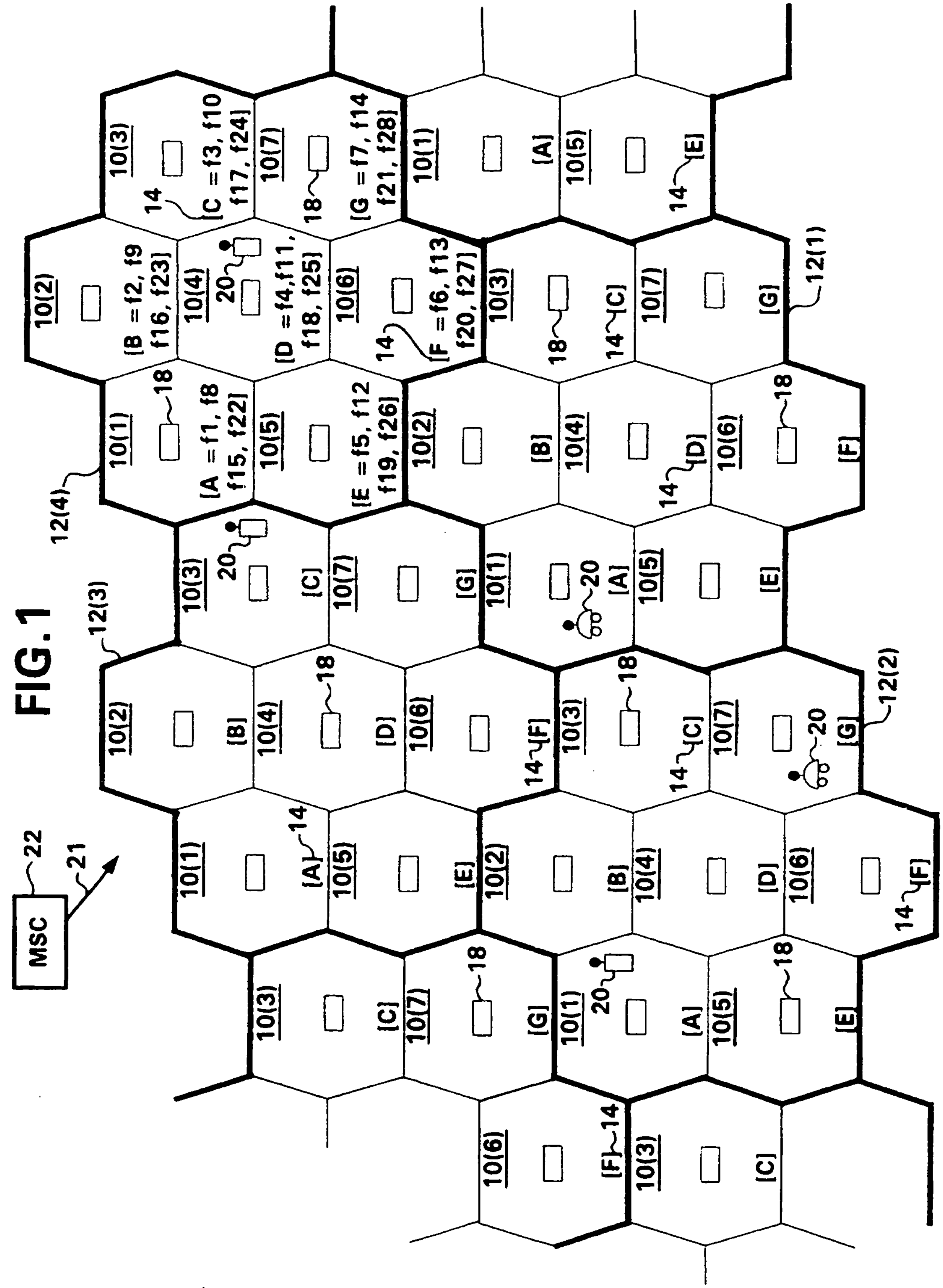

MSC
22
21
[A = f1, f8 f15, f22]
[B = f2, f9 f16, f23]
[C = f3, f10 f17, f24]
[D = f4, f11, f18, f25]
[E = f5, f12 f19, f26]
[F = f6, f13 f20, f27]
[G = f7, f14 f21, f28]
10(1)
10(2)
10(3)
10(4)
10(5)
10(6)
10(7)
12(1)
12(2)
12(3)
12(4)
14
18
20

FIG. 1

FIG.2

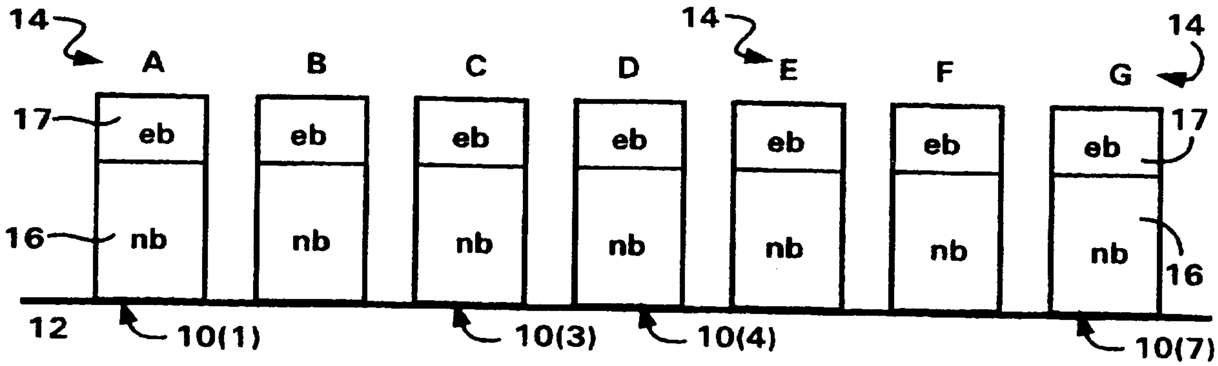


FIG.3

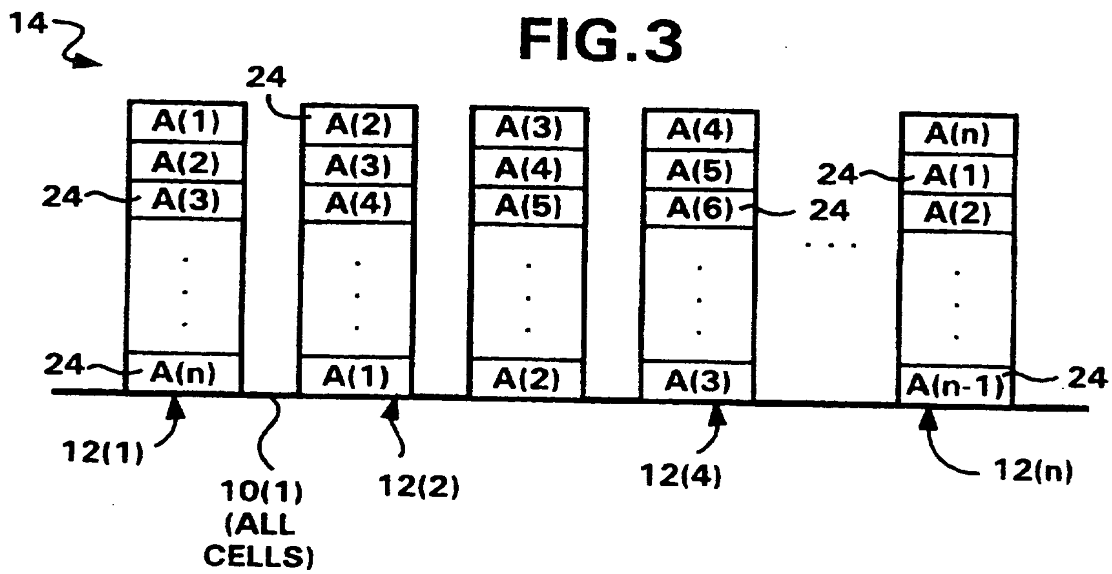


FIG.5

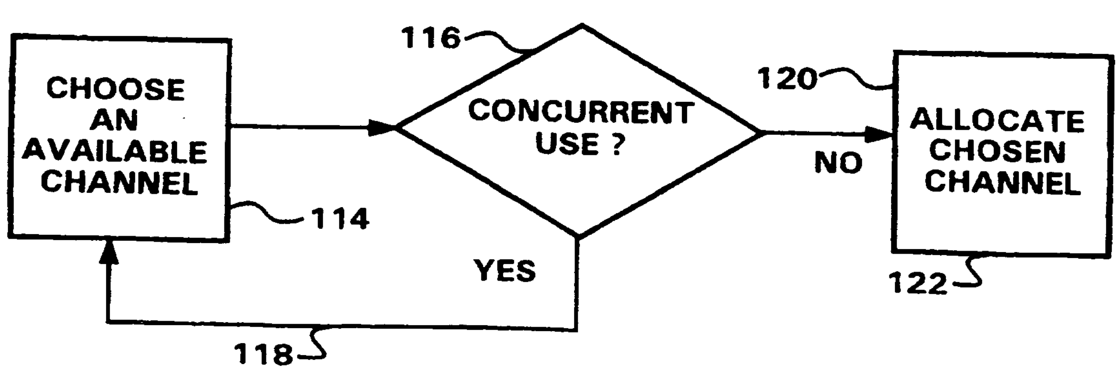
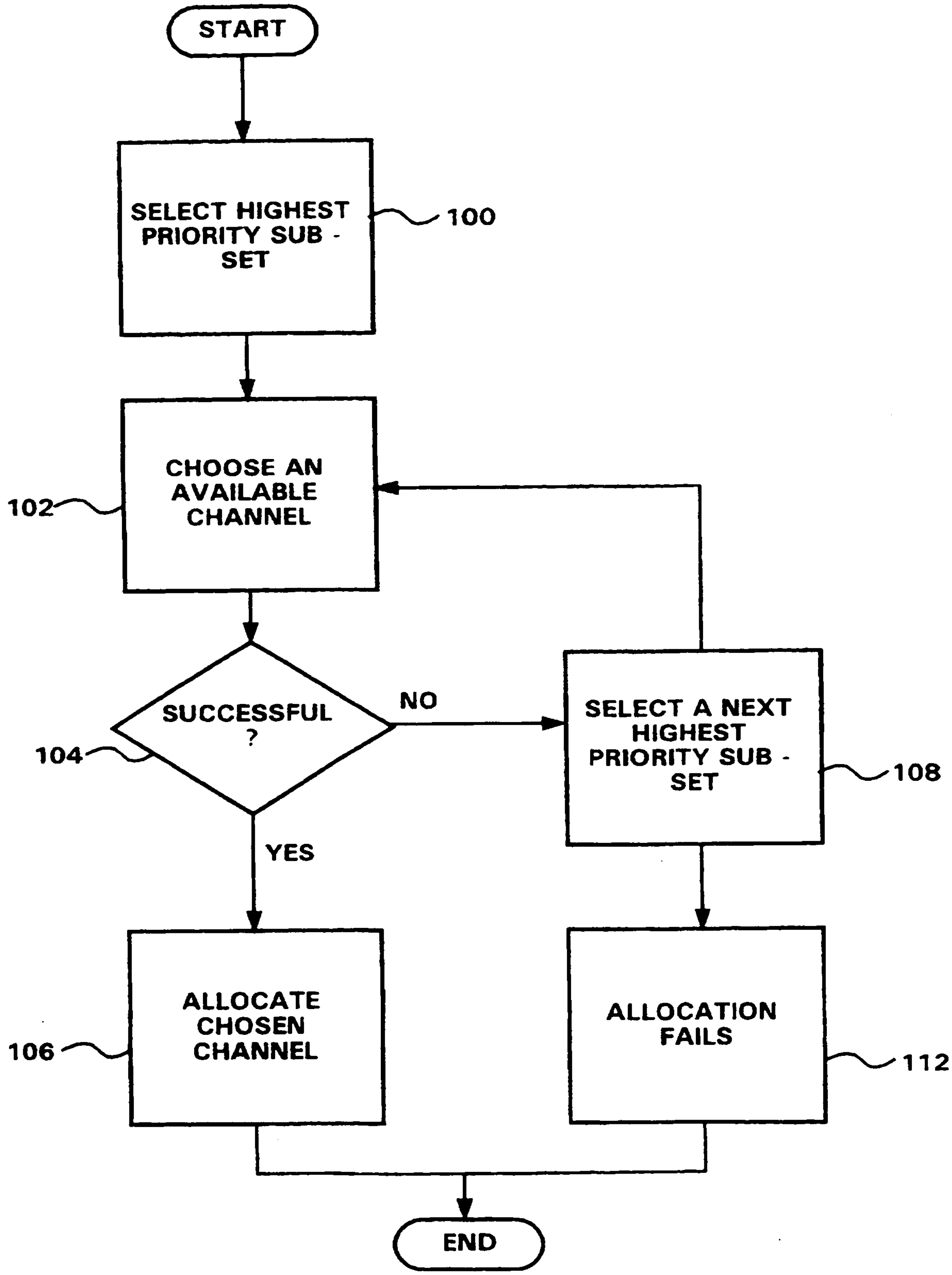


FIG.4


START
SELECT HIGHEST PRIORITY SUB - SET
100
CHOOSE AN AVAILABLE CHANNEL
102
SUCCESSFUL ?
104
NO
YES
SELECT A NEXT HIGHEST PRIORITY SUB - SET
108
ALLOCATE CHOSEN CHANNEL
106
ALLOCATION FAILS
112
END

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 97/00306

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 07013 A (ERICSSON TELEFON AB L M) 9 March 1995	1-3,5-8, 10-12, 14,15, 17-21, 23-25,27
Y	see page 9, line 21 - page 10, line 27 see page 11, line 15 - page 12, line 4 see page 12, line 19 - page 13, line 11; figures 1,2,4 ---	4,9,13, 16,22,26
Y	IEEE COMMUNICATIONS MAGAZINE, vol. 29, no. 11, 1 November 1991, pages 19-23, XP000279120 LEE W C Y: "SMALLER CELLS FOR GREATER PERFORMANCE" see page 19, column 1 ---	4,9,13, 16,22,26

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
21 July 1997	31.07.97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Schut, G

Form PCT/ISA/210 (second sheet) (July 1992)

International application No
PCT/SE 97/00306

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 441 372 A (NIPPON ELECTRIC CO ;NIPPON TELEGRAPH & TELEPHONE (JP)) 14 August 1991 see column 4, line 40 - column 5, line 10 see column 6, line 8 - column 6, line 57; figures 1,2,4	1,3,6,8, 11,12, 15, 18-21, 24,25

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/SE 97/00306

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9507013 A	09-03-95	US 5507034 A	09-04-96
		AU 678530 B	29-05-97
		AU 7627094 A	22-03-95
		CN 1115198 A	17-01-96
		EP 0667092 A	16-08-95
		FI 952062 A	28-04-95
EP 0441372 A	14-08-91	JP 3234130 A	18-10-91
		JP 3234131 A	18-10-91
		AU 646835 B	10-03-94
		AU 7091691 A	15-08-91
		CA 2035963 A	09-08-91
		CA 2035963 C	20-09-94
		DE 69111629 D	07-09-95
		DE 69111629 T	29-02-96
		US 5263176 A	16-11-93